

# PATENT ABSTRACTS OF JAPAN

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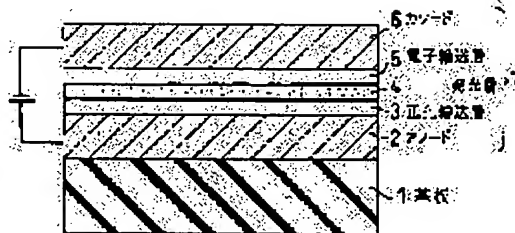
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## (54) ORGANIC EL ELEMENT AND DISPLAY DEVICE

### (57)Abstract:

PROBLEM TO BE SOLVED: To provide an organic EL element having a long service life and to provide a display device using it and having a long service life.

SOLUTION: This organic EL element emits light from a luminescent layer 4 by exciting pigment molecules in the luminescent layer 4 containing host molecules and the pigment molecules of luminescent centers. The organic EL element is characterized in that the pigment molecule is a red light emitting pigment molecule having a cyano group, and its octanol Log P value is 6.5 or more.



## LEGAL STATUS

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Notes:

1. Untranslatable words are replaced with asterisks (\*\*\*\*).
2. Texts in the figures are not translated and shown as it is.

Translated: 06:52:57 JST 03/28/2006

Dictionary: Last updated 03/24/2006 / Priority: 1. Chemistry / 2. Natural sciences

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## CLAIMS

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### [Claim(s)]

[Claim 1] It is arranged between an anode, a cathode, and said anode and a cathode. Provide the luminous layer containing a host molecule and the dye molecule of a luminescence center, make the electron supplied from the positive hole supplied from said anode, and said cathode recombine in said luminous layer, and said host molecule is excited. The energy of said excited host molecule is moved to the dye molecule of said luminescence center. The organic EL device characterized by being the organic EL device which makes the dye molecule of said luminescence center emit light, and for said dye molecule being a luminescent color matter molecule which has a cyano group, and the octanol LogP value being 6.5 or more.

[Claim 2] The organic EL device according to claim 1 characterized by said octanol LogP value being 12 or less.

[Claim 3] The organic EL device according to claim 1 characterized by said dye molecule having carbon-fluorine binding.

[Claim 4] It is the organic EL device according to claim 1 which said host molecule is polymer and is characterized by distributing said dye molecule in said luminous layer by making said polymer into a matrix.

[Claim 5] Said luminous layer is an organic EL device according to claim 4 characterized by including the monomer possessing the alkyl group which is not replaced [ with an or more 1 carbon number / or less 20 ], the alkyl group replaced by the with an or more 1 carbon number [ or less 20 ] halogen atom, and the alkyl group replaced by the with an or more 1 carbon number [ or less 20 ] aryl group.

[Claim 6] The organic EL device according to claim 1 characterized by said dye molecule possessing a dicyanomethylene machine.

[Claim 7] Are the display device which possesses the arranged organic EL device, and displays by luminescence of the organic EL device concerned on a substrate and this

substrate, and each of the arranged organic EL device on said substrate. An anode, The luminous layer which is arranged between a cathode, and said anode and a cathode, and contains a host molecule and the dye molecule of a luminescence center is provided. Make the electron supplied from the positive hole supplied from said anode, and said cathode recombine in said luminous layer, and said host molecule is excited. It is the organic EL device which moves the energy of said excited host molecule to the dye molecule of said luminescence center, and makes the dye molecule of this luminescence center emit light. At least one of the organic EL devices arranged on said substrate is the display device characterized by for said dye molecule being a luminescent color matter molecule which has a cyano group, and the octanol LogP value being 6.5 or more. [ two or more ]

## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an organic EL device and a display device.

[0002]

[Description of the Prior Art] The organic EL device attracts attention as a candidate of the display of the next generation which may exceed a liquid crystal display from the feature which enables a spontaneous light type, a thin light weight, low power consumption, and full color-ization. In order to enable full color-ization, it is necessary to arrange the three primary colors of red and a green and blue light on a substrate. About green luminescence, sufficient luminance and a long-life life are already attained and put in practical use among these three primary colors. However, about neither red nor blue light, still sufficient luminance and a long-life life are not attained, and full color-ization can be realized.

[0003] [ red light ] as one of the methods which attains high-intensity-izing and reinforcement between these two colors The dye molecule which carries out red light is doped in a host molecule by low concentration, a positive hole and an electron are made to recombine, a host molecule is excited, the energy of the excited host molecule is moved to a dye molecule, and the guest host dope system who makes a dye molecule emit light is developed.

[0004] As a pigment which is used for this guest host dope system and which carries out red light, there are some which are represented in 4-(dicyanomethylene)-2-methyl 6-(p-dimethylaminostyryl)-4H-Piran (DCM). This pigment uses a cyano group as an electronic acceptor machine, it is the push pull molecule which combined an electronic donor machine like an amino group with the conjugate chain, and there are high-intensity and a report that it is effective long lasting (JP,H10-308281,A).

[0005] However, a push pull molecule has high polarity, and is difficult to be easy to mix a polar impurity during synthesis, since it has the cyano group which reacts to water, oxygen,

etc. easily, and to remove a polar impurity. A polar impurity has the problem which causes excessive leak electric current etc. and reduces the life of an element. The problem of mixing of this polar impurity has throughput remarkable in especially the cast method or the printing method that is a comparatively good method.

[0006] Thus, the push pull molecule which combined an electronic donor machine like an amino group with the conjugate chain has high-intensity and the report that it is effective long lasting, by using a cyano group as an electronic acceptor machine. However, the dye molecule which actually has a strong polar group like a manufacture top cyano group has the problem which reduces the life of an element that it is easy to mix a polar impurity. Moreover, there is a problem that luminous efficiency falls that the meeting power of the dye molecules which have a strong polar group like a cyano group is large, and it is easy to carry out phase separation to a host molecule. Moreover, by carrying out phase separation, if a dye molecule does not distribute uniformly in a host molecule, the luminance of luminescence will fall, and there is a problem that a tint will become a bad thing crude as a display device. These problems attain 10,000 or more reduction-by-half time, and the red organic EL device with good luminous efficiency and a good tint is not yet realized.

[0007]

[Problem to be solved by the invention] As mentioned above, luminance and a life (reduction-by-half time 10,000 hours or more) sufficient by red light are realized, and the organic EL device with good red \*\*\*\* is not realized. Moreover, since the trial and life of the red EL element are not improved, there is a problem that the high definition full color display device which used red, blue, and the green three primary colors is not realizable.

[0008] This invention is made in view of such a problem, and offers the organic EL device of the red light which attained sufficient luminance and a sufficient life. Moreover, it aims at offering the full color display device using the red using this, blue, and the green three primary colors.

[0009]

[Means for solving problem] In order to attain the above-mentioned purpose, this invention is arranged between an anode, a cathode, and said anode and a cathode. Provide the luminous layer containing a host molecule and the dye molecule of a luminescence center, make the electron supplied from the positive hole supplied from said anode, and said cathode recombine in said luminous layer, and said host molecule is excited. The energy of said excited host molecule is moved to the dye molecule of said luminescence center. It is the organic EL device which makes the dye molecule of said luminescence center emit light, and said dye molecule is a luminescent color matter molecule which has a cyano group, and the organic EL device characterized by the octanol LogP value being 6.5 or more is offered.

[0010] At this time, it is desirable that said octanol LogP value is 12 or less.

[0011] Moreover, it is desirable that said dye molecule has carbon-fluorine binding.

[0012] Moreover, said host molecule is polymer and, as for said dye molecule, it is desirable to distribute in said luminous layer by making said polymer into a matrix. Said host molecule is polymer and it is desirable that said dye molecule is distributed in said luminous layer.

[0013] Moreover, as for said luminous layer, it is desirable that the monomer possessing the alkyl group which is not replaced [ with an or more 1 carbon number / or less 20 ], the alkyl group replaced by the with an or more 1 carbon number [ or less 20 ] halogen atom, and the alkyl group replaced by the with an or more 1 carbon number [ or less 20 ] aryl group is included.

[0014] Moreover, it is desirable that said dye molecule possesses a dicyanomethylene machine.

[0015] This invention is a display device which possesses the arranged organic EL device, and displays by luminescence of the organic EL device concerned on a substrate and this substrate, and each of the arranged organic EL device on said substrate Moreover, an anode, The luminous layer which is arranged between a cathode, and said anode and a cathode, and contains a host molecule and the dye molecule of a luminescence center is provided. Make the electron supplied from the positive hole supplied from said anode, and said cathode recombine in said luminous layer, and said host molecule is excited. It is the organic EL device which moves the energy of said excited host molecule to the dye molecule of said luminescence center, and makes the dye molecule of this luminescence center emit light. Said dye molecule is a luminescent color matter molecule which has a cyano group, and at least one of the organic EL devices arranged on said substrate offers the display device characterized by the octanol LogP value being 6.5 or more. [ two or more ]

[0016]

[Mode for carrying out the invention] this invention person investigated the reduction-by-half life by making the octanol LogP value of the dye molecule of a red light pigment into a parameter about the organic EL device which doped the red light pigment which has a cyano group to the luminous layer and which carries out red light.

[0017] Drawing 2 is the experimental result which this invention person performed, and is the figure which took the reduction-by-half life along the vertical axis, and took the octanol LogP value along the horizontal axis.

[0018] As shown in drawing 2 , in the place where an octanol LogP value is smaller than 6.5, a reduction-by-half life is 6000 or less hours, and it turns out that 10,000 hours cannot be attained. As these experiments show, in this invention, by adding the dye molecule which makes an octanol LogP value 6.5 or more in a host molecule shows that it becomes possible to attain reinforcement of an organic EL device.

[0019] Here, an octanol LogP value is a hydrophobic parameter and is logarithm which uses

10 of the partition ratio  $P$  of 1-octanol solution and an aqueous solution as a bottom. The survey method melts and agitates solute in the mixed liquor of 1-octanol and water, and it neglects it until 1-octanol solution and an aqueous solution carry out phase separation. 1-octanol solution and an aqueous solution are extracted, respectively, and the concentration of the solute which has melted into 1-octanol solution, and the concentration of the solute which has melted into the aqueous solution are measured. And  $P = (\text{concentration of solute which has melted into 1-octanol solution}) / (\text{concentration of the solute which has melted into the aqueous solution})$  is calculated, and an octanol LogP value is measured. 25 degrees C which is a standard state, and 1 atmosphere perform these measurement.

[0020] An octanol LogP value has very many actual measurements, and the experience parameter has also gathered, and it is known that an actual measurement and a calculated value are well in agreement.

[0021] The octanol LogP value used by this invention was calculated on the personal computer using HyperChemv5.1 by Hypercube. The calculation method calculates the optimal conformation of a dye molecule using molecular force field calculation (MM+) first. LogP was calculated and calculated using the experiential QSAR (Quantitative Structure-Activity Relationships) program v.1.6 about the structure of the pigment.

[0022] Next, the characteristics of an octanol LogP value and an element life consider below that an octanol LogP value has a threshold in 6.5, as shown in drawing 2.

[0023] First, an octanol LogP value is an equilibrium constant. Therefore, an octanol LogP value is proportional to the difference ( $\Delta G$ ) of the free energy per unit concentration when a dye molecule melts into an octanol solution and an aqueous solution.

[0024] It can be said that the dye molecule becomes that to exist in octanol is more stable, and its hydrophobicity is stronger than water, so that  $\Delta G = -2.3RT \log P$ , therefore an octanol LogP value are large. That is, an octanol LogP value and hydrophobicity are in proportionality relation.

[0025] Then, explanation of the graph shown in drawing 2 will consider that the hydrophobicity of a dye molecule becomes difficult to mix a polar impurity rapidly in a certain threshold which becomes large. If the threshold is expressed with an octanol Log value, it will be thought that it is set to 6.5.

[0026] Moreover, it is thought apparently that the threshold of an octanol LogP value naturally changes also according to the kind of host molecule. Since a dye molecule has a cyano group, in high polarity, with the dye molecule with which a polar impurity has a polar high cyano group, mixing is carried out to a \*\* sake and easy is influenced at it. Since as for this the hydrophobic large molecule is far used for the host molecule in practice rather than the dye molecule which has a cyano group even if the dye molecule is contained only to the percent order to the host molecule, It is shown that a polar high impurity is decided not with the

hydrophobic, usual, very large host molecule but with the dye molecule containing a polar high cyano group. That is, an impurity meets easily with the dye molecule which has a cyano group, and not to be influenced is considered by the kind of hydrophobic host molecule.

[0027] The above consideration showed that it is not based on the kind of host molecule, but the reduction-by-half life of 10,000 hours or more could be attained with [ the octanol Log value of the dye molecule which has a cyano group ] 6.5 [ or more ].

[0028] Moreover, since the hydrophobic large dye molecule with a large octanol LogP value is stably distributed in a hydrophobic large host molecule from these experiments, it is thought that an element life becomes long. This is because dispersion becomes uneven and a life is conversely considered to become short, when it becomes high temperature by element drive or polar impurities, such as water, mix even if the hydrophobic small dye molecule with a small octanol LogP value meets easily and it is distributing uniformly in early stages.

[0029] Moreover, since the LogP value of a dye molecule can be made to increase by having carbon-fluorine binding into a dye molecule, it is desirable. Moreover, the energy of the dye molecule which the electron excited since resonant frequency was low compared with the carbon-hydrogen bond is lost as thermal energy of vibration, and carbon-fluorine binding is a difficulty stake. When it is hard to be lost as thermal energy, non-radiated deactivation decreases and there is the feature that luminous efficiency increases.

[0030] Moreover, it is desirable that the dye molecule is distributed in a polymer layer. The organic EL device of the polymer type with which the dye molecule was distributed in the polymer layer is difficult for the cast from a solution, or generally removing an impurity, since it is printing and producing. Then, it is because it becomes possible by using 6.5 or more dye molecules for a polymer type organic EL device for an octanol LogP value like this invention to control mixing of a polar impurity effectively.

[0031] Moreover, it is desirable that a polymer layer is the alkyl group replaced by the alkyl group which has monomeric unit structure repeatedly and was replaced by monomeric unit structure by non-replaced the alkyl group or halogen atom of carbon numbers 1-20, or the aryl group. If it has the alkyl group replaced by the alkyl group replaced by the monomeric unit by non-replaced the alkyl group or halogen atom of carbon numbers 1-20, or the aryl group It is because the hydrophobicity of polymer itself becomes high, familiarity by the dye molecule of 6.5 or more hydrophobicity with a high octanol LogP value becomes good and a distributed state becomes stable.

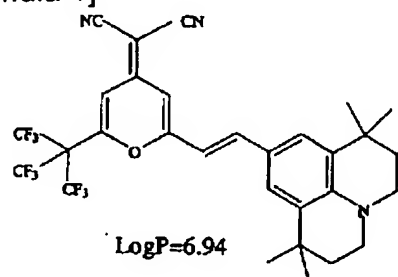
[0032] Moreover, it is desirable that the dye molecule has a dicyanomethylene machine. It is because a dicyanomethylene machine has dramatically strong acceptor nature, and it is desirable in order to realize clear red light. Moreover, since polarity is also dramatically large, especially the effect when making an octanol LogP value or more into 6.5 of a dicyanomethylene machine is also large.



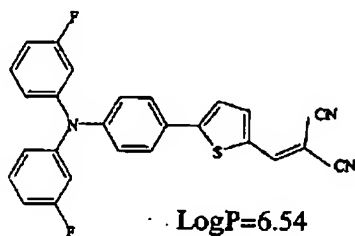
[0033] Below, the chemical formulas of a thing typical as a red light pigment in this invention are enumerated with the octanol LogP value.

[Chemical formula 1]

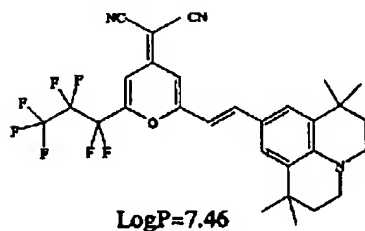
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(2)

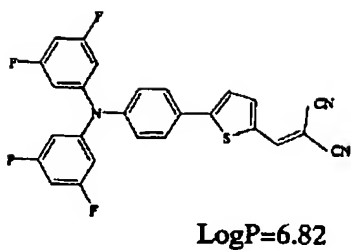


(3)

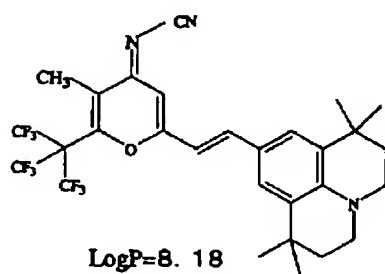


[Chemical formula 2]

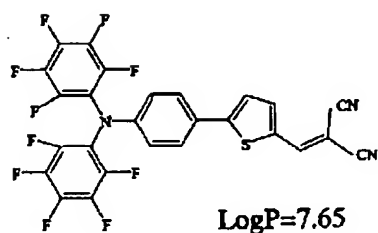
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(5)

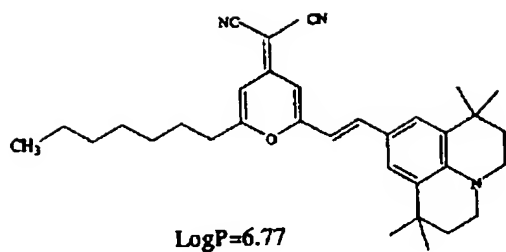


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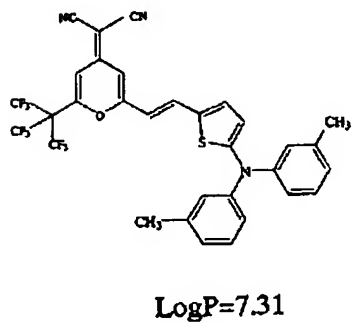


[Chemical formula 3]

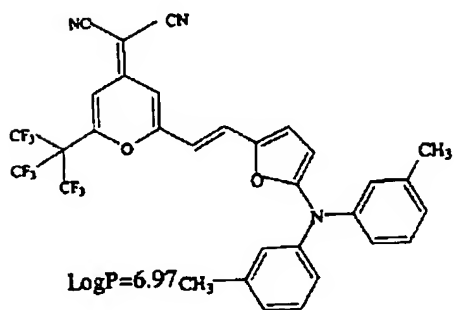
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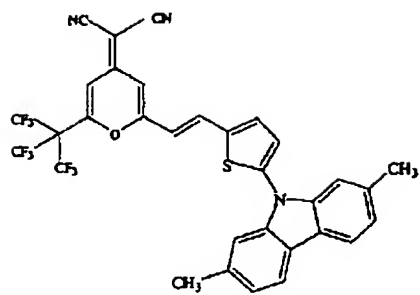


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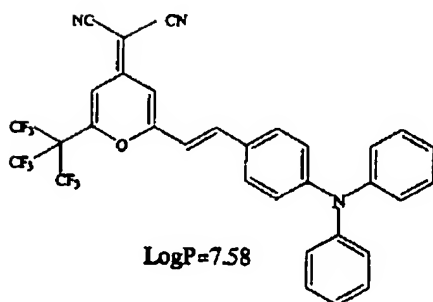
[Chemical formula 4]

(10)



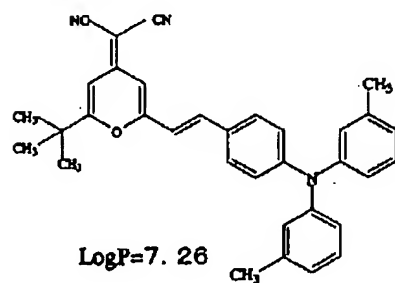
LogP=6.95

(11)



LogP=7.58

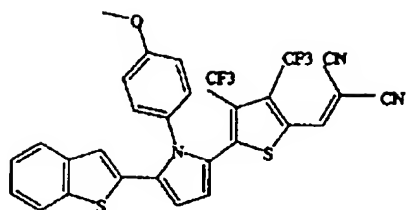
(12)



LogP=7.26

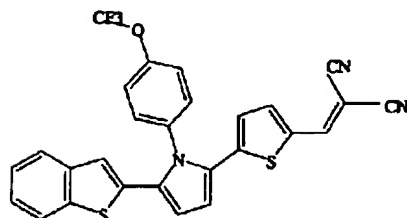
[Chemical formula 5]

(13)



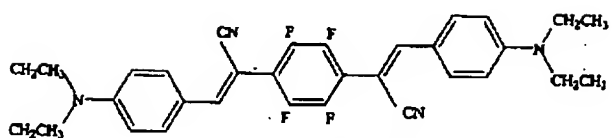
LogP=6.80

(14)



LogP=6.97

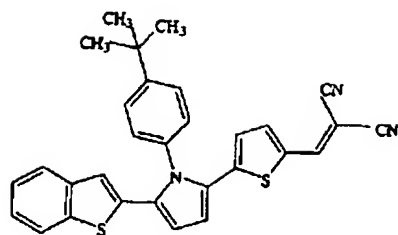
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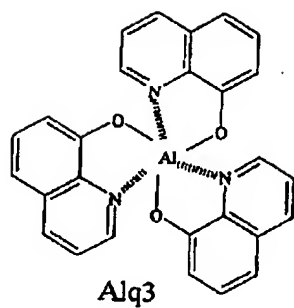
LogP=8.38

[Chemical formula 6]

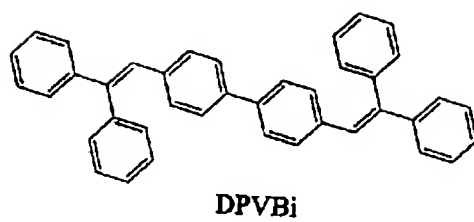
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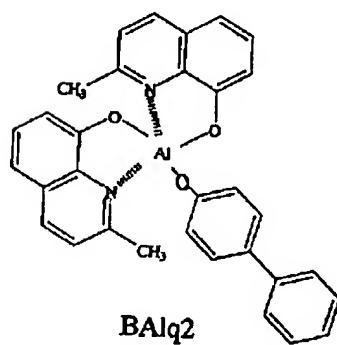
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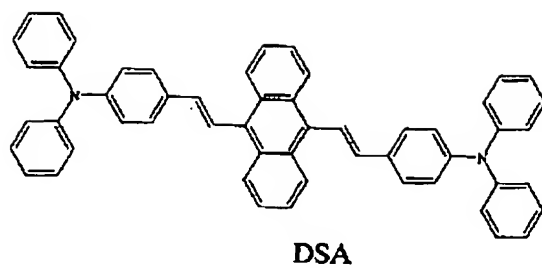


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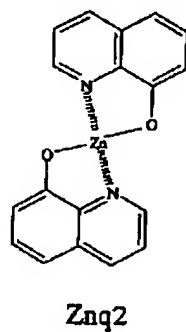


[Chemical formula 8]

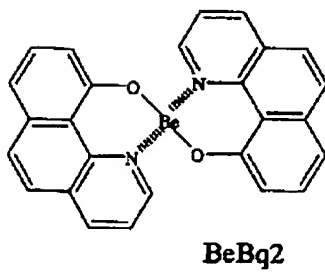
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(22)



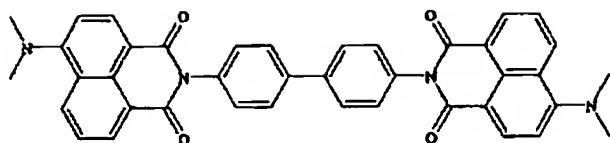
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[Chemical formula 9]

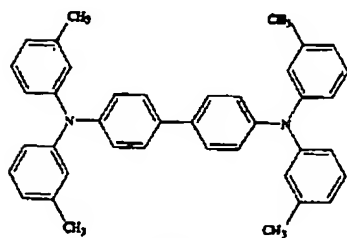


(24)



DNA

(25)

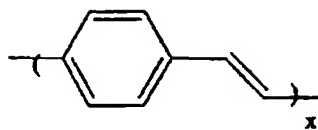


TPD

Moreover, the chemical formulas of a thing typical as a polymer host molecule are enumerated below. In the inside R of a chemical formula, no replacing or a displacement hydrocarbon with 1-20 anthrax is shown independently, respectively.

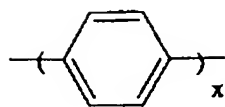
[Chemical formula 10]

(26)



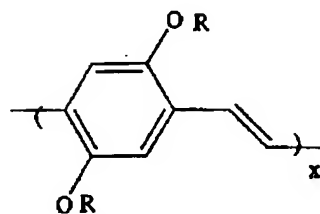
PPV

(27)



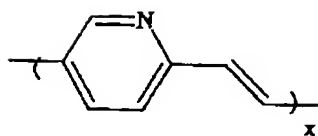
PPP

(28)



RO-PPV

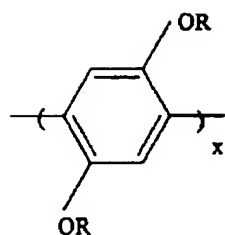
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PPyV

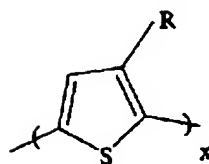
[Chemical formula 11]

(30)



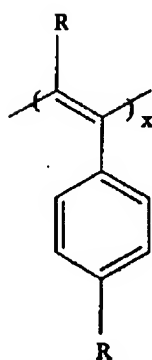
RO-PPP

(31)



PAT

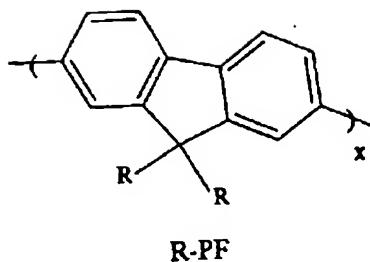
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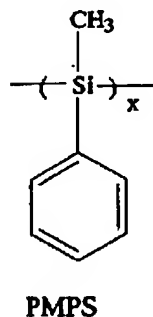
PAPA

[Chemical formula 12]

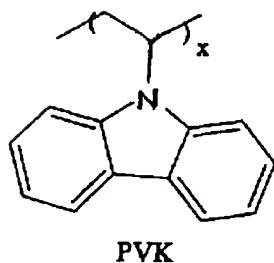
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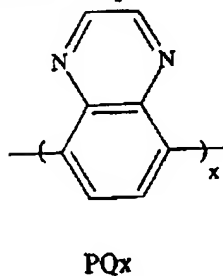


(35)



[Chemical formula 13]

(36)



An example of the organic EL device of this invention is shown in drawing 1 , and this invention is explained with reference to drawing 1 below.

[0034] The organic EL device 7 shown in drawing 1 is formed in the substrate 1 surface. This organic EL device 7 is having structure where an anode 2, the positive hole transportation

layer 3, the luminous layer 4 that doped the luminescent molecule in the host molecule, the electronic transportation layer 5, and the cathode 6 were laminated one by one from the substrate 1 side.

[0035] The electron with which the positive hole supplied from the anode 2 was supplied to the luminous layer 4 from the cathode 6 through the positive hole transportation layer reaches to a luminous layer 4 through the electronic transportation layer 5. As a result, the host molecule in a luminous layer 4 is excited because a positive hole and an electron recombine in a luminous layer 4, and a host molecule has two energy states of a singlet excited state and a triplet excited state. And the energy of the singlet excited state of a host molecule moves to the dye molecule of a luminescence center, and shows the red light according to this energy.

[0036] Moreover, when the dye molecule which is a luminescence center determines the luminescent color of an organic EL device substantially and a rare earth metal ion complex is used [ for example, ], a luminous wavelength can be adjusted by choosing the rare earth elements to be used. Moreover, when using a normal chain-like pi electron conjugated system polymer, a luminous wavelength can be adjusted by choosing the frame etc.

[0037] Next, in the organic EL device 7 of such structure, various things to which the octanol LogP value was changed as a dye molecule which is a luminescence center were produced, and the luminance reduction-by-half life was measured.

[0038] (Embodiment 1) It is iodinated first. A Grignard reagent is produced by using perfluoro t-butyl as a raw material. This Grignard reagent and acetaldehyde are made to react and an alcohol is produced. Dehydration of this alcohol is carried out and it is perfluoro t-butyl. Methyl Ketone is compounded.

[0039] Next, this perfluoro t-butyl Methyl The compound obtained by having made ketone and boron trifluoride etherate react 2, 6-lutidine, N,N-dimethylacetamide Dimethyl After making it react with acetal, processed with perchloric acid, next it was made to react with MARONI tolyl, and the cyano group was introduced. Next, the octanol LogP value compounded the compound indicated at a ceremony (1) of 6.94 by making 9-formyl 1, 1, 7, and 7-tetramethyl durolysine react, and carrying out separation refinement by liquid chromatograph.

[0040] Next, the transparent electric conduction film which consists of indium \*\*\*\*- oxide (ITO) etc. as an anode 2 is formed on the transparent insulating substrates 1, such as glass. this anode 2 top -- ultraviolet radiation -- and ozone washing is carried out.

[0041] Next, the vacuum deposition of the N and N'N, N'-diphenyl benzidine film is carried out on an anode 2 as a positive hole transportation layer 3. [ - \*\*\*\*- (1-naphthyl) - ] The thickness of the positive hole transportation layer 3 may be 60nm. At this time, you may form a hole injection layer between the positive hole transportation layer 3 and an anode 2. The hole injection layer should just be a substance which has those middle band gaps, in order to make low the band gap of an anode 2 and the positive hole transportation layer 3. For example,

copper phthalocyanine etc. can be used. The thickness of a hole injection layer should just be about 15nm.

[0042] Next, the vacuum deposition of the host molecular film which consists of a compound (Alq3) indicated at a ceremony (18) as a luminous layer 4 is carried out. In this host molecule, the compound indicated at a ceremony (1) is added 1%. Moreover, the thickness of a luminous layer 4 may be 40nm.

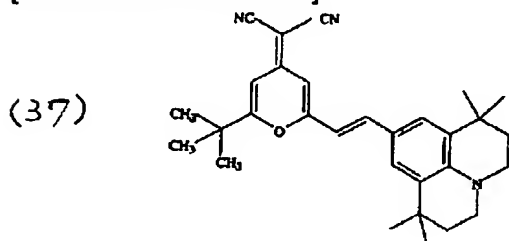
[0043] Next, the vacuum deposition of the film which consists of a compound (Alq3) similarly indicated at a ceremony (18) as an electronic transportation layer 5 is carried out on a luminous layer 4. The thickness of the electronic transportation layer 5 may be 40nm.

[0044] Next, the vacuum deposition of the MgAl film which consists of an atomic ratio of 10:1 is carried out on the electronic transportation layer 5 as a cathode 6. The thickness of a cathode 6 may be 200nm. An element carries out a seal package into a desiccation glow box after this.

[0045] Thus, the formed organic EL devices were 500 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 13V. Moreover, the luminance reduction-by-half lives at the time of carrying out a continuation drive were 10000 hours and a life long enough.

[0046] (Comparative example 1) Next, in drawing 1, the octanol LogP value produced the organic EL device which added the compound indicated at a ceremony (37) which is 5.70 to the luminous layer 4 1% as a comparative example. Other composition and material are the same as that of the embodiment 1.

[Chemical formula 14]

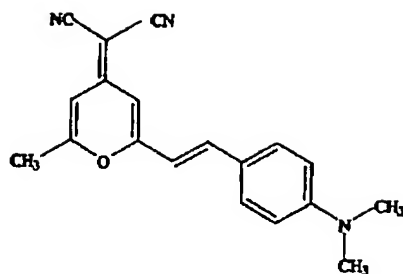


This organic EL device was 450 cm/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as inadequate as 5000 hours.

[0047] (Comparative example 2) Next, in drawing 1, the octanol LogP value produced the organic EL device which added the compound indicated at a ceremony (38) which is 2.04 to the luminous layer 4 1% as a comparative example. Other composition and material are the same as that of the embodiment 1.

[Chemical formula 15]

(38)



This organic EL device was 500 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14.5V. The luminance reduction-by-half life at the time of carrying out a continuation drive was completely as inadequate as 1000 hours.

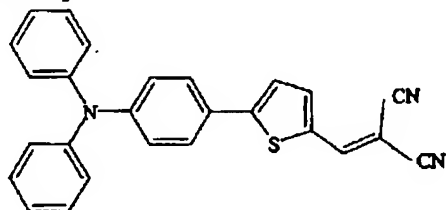
[0048] (Embodiment 2) Next, in drawing 1, the octanol LogP value produced the organic EL device which added the compound indicated at a ceremony (2) which is 6.54 to the luminous layer 4 1%. Other composition and material are the same as that of the embodiment 1.

[0049] This organic EL device was 450 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as long enough as 12000 hours.

[0050] (Comparative example 3) Next, in drawing 1, the octanol LogP value produced the organic EL device which added the compound indicated at a ceremony (39) which is 6.26 to the luminous layer 4 1% as a comparative example. Other composition and material are the same as that of the embodiment 1.

[Chemical formula 16]

(39)



This organic EL device was 450 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 15.5V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as inadequate as 4000 hours.

[0051] (Embodiment 3) Next, in drawing 1, the octanol LogP value produced the organic EL device which added the compound indicated at a ceremony (3) which is 7.46 to the luminous layer 4 1%. Other composition and material are the same as that of the embodiment 1.

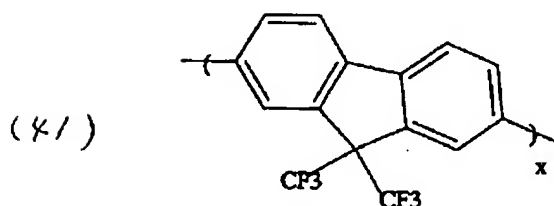
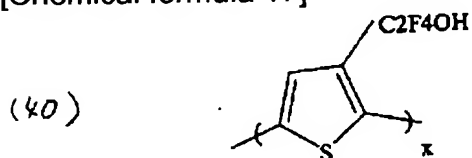
[0052] This organic EL device was 500 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 13V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as long enough as 12000 hours.

[0053] (Embodiment 4) In drawing 1, the transparent electric conduction film which consists of indium \*\*\*\*- oxide (ITO) etc. as an anode 2 is formed on the transparent insulating substrates 1, such as glass. this anode 2 top -- ultraviolet radiation -- and ozone washing is carried out.

[0054] Next, the film which consists of a compound indicated at a ceremony (40) as a positive hole transportation layer 3 is formed with a spin coat on an anode 2. The thickness of the positive hole transportation layer 3 may be 30nm. At this time, you may form a hole injection layer between the positive hole transportation layer 3 and an anode 2. The hole injection layer should just be a substance which has those middle band gaps, in order to make low the band gap of an anode 2 and the positive hole transportation layer 3. For example, copper phthalocyanine etc. can be used. The thickness of a hole injection layer should just be about 15nm.

[0055] Next, the host molecular film which consists of a compound indicated at a ceremony (41) as a layer which serves both as the polymer luminous layer 4 and the electronic transportation layer 5 is formed with a spin coat. In this host molecule, the compound indicated at a ceremony (4) is added 1%. The octanol LogP value of the compound indicated at a ceremony (4) is 6.82. Moreover, the thickness of the film which serves both as the polymer luminous layer 4 and the electronic transportation layer 5 may be 30nm.

[Chemical formula 17]



Next, the vacuum deposition of the MgAl film which consists of an atomic ratio of 10:1 is carried out on the electronic transportation layer 5 as a cathode 6. The thickness of a cathode 6 may be 200nm. An element carries out a seal package into a desiccation glow box after this.

[0056] Thus, the formed organic EL devices were 350 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 13V. Moreover, the luminance reduction-by-half lives at the time of carrying out a continuation drive were 15000 hours and a life long enough.

[0057] (Comparative example 4) Next, in drawing 1, the octanol LogP value produced the



organic EL device for which the compound indicated at a ceremony (39) which is 6.26 was added in the layer which serves both as a luminous layer 4 and the electronic transportation layer 5 1% as a comparative example. Other composition and material are the same as that of the embodiment 4.

[0058] This organic EL device was 350 cm/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as inadequate as 3000 hours.

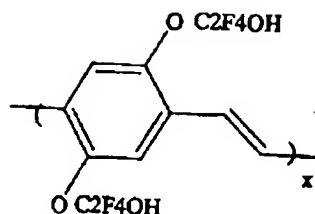
[0059] (Embodiment 5) In drawing 1, the transparent electric conduction film which consists of indium \*\*\*\*- oxide (ITO) etc. as an anode 2 is formed on the transparent insulating substrates 1, such as glass. this anode 2 top -- ultraviolet radiation -- and ozone washing is carried out.

[0060] Next, the film which consists of a compound indicated at a ceremony (42) as a positive hole transportation layer 3 is formed with a spin coat on an anode 2. The thickness of the positive hole transportation layer 3 may be 30nm. At this time, you may form a hole injection layer between the positive hole transportation layer 3 and an anode 2. The hole injection layer should just be a substance which has those middle band gaps, in order to make low the band gap of an anode 2 and the positive hole transportation layer 3. For example, copper phthalocyanine etc. can be used. The thickness of a hole injection layer should just be about 15nm.

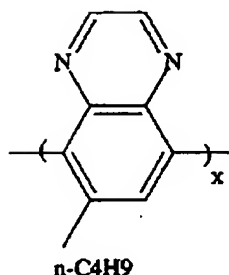
[0061] Next, the host molecular film which consists of a compound indicated at a ceremony (43) as a layer which serves both as the polymer luminous layer 4 and the electronic transportation layer 5 is formed with a spin coat. In this host molecule, the compound indicated at a ceremony (15) is added 1%. The octanol LogP value of the compound indicated at a ceremony (15) is 8.38. Moreover, the thickness of the layer which serves both as the polymer luminous layer 4 and the electronic transportation layer 5 may be 30nm.

[Chemical formula 18]

(42)



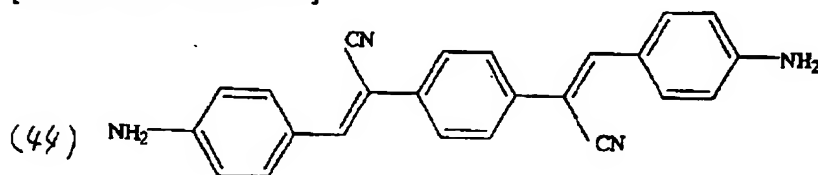
(43)



Next, the vacuum deposition of the MgAl film which consists of an atomic ratio of 10:1 is carried out on the electronic transportation layer 5 as a cathode 6. The thickness of a cathode 6 may be 200nm. An element carries out a seal package into a desiccation glow box after this. [0062] Thus, the formed organic EL devices were 400 cd/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14V. Moreover, the luminance reduction-by-half lives at the time of carrying out a continuation drive were 18000 hours and a life long enough.

[0063] (Comparative example 5) Next, in drawing 1, the octanol LogP value produced the organic EL device for which the compound indicated at a ceremony (44) which is 4.36 was added in the layer which serves both as a luminous layer 4 and the electronic transportation layer 5 1% as a comparative example. Other composition and material are the same as that of the embodiment 5.

[Chemical formula 19]



This organic EL device was 350 cm/m<sup>2</sup>, when a red light output drove with the bias voltage which is the current sourcing of 20 mA/cm<sup>2</sup>, and 14V. The luminance reduction-by-half life at the time of carrying out a continuation drive was as inadequate as 2000 hours.

[0064] The relation between an element life and a LogP value was shown in drawing 2 using

what has various octanol LogP values as a dye molecule which is based on red light using various host molecules also including the above embodiment and comparative example.

[0065] As shown in drawing 2 , in the place where an octanol LogP value is smaller than 6.5, it turns out that the reduction-by-half life is short rapidly.

[0066] In this invention, it becomes possible by adding 6.5 or more dye molecules for an octanol LogP value in a host molecule to attain reinforcement of an organic EL device so that these experiments may show.

[0067] (Embodiment 6) Next, the display device using the organic EL device which is the example of this invention is explained.

[0068] Drawing 3 is the outline sectional view showing the stroke matter of the display device of this invention.

[0069] The septum 34 which becomes the transparent base 31 surface which has the insulation of glass etc. from an insulating material is formed. The organic EL device of this invention is formed in each cell separated by the septum 34. that is, On the substrate 1 surface, transparent electrodes, such as ITO (For example, anode) Three organic EL devices with which the counter electrode (for example, cathode) 39 which consists of 33, the positive hole transportation layer 35 which consists of a compound indicated at a ceremony (40), the polymer luminous layer 36 with electronic transportation ability, 37 or 38, and Ca was formed one by one are separated and formed by the septum 34.

[0070] the polymer luminous layer 37 has [ the polymer luminous layer 36 ] a green material in which red (R) fluorescence is shown as a dye molecule of a luminescence center as a dye molecule of a luminescence center -- the material which, as for the polymer luminous layer 38, the material in which the fluorescence of (G) is shown shows blue (B) fluorescence as a dye molecule of a luminescence center is used.

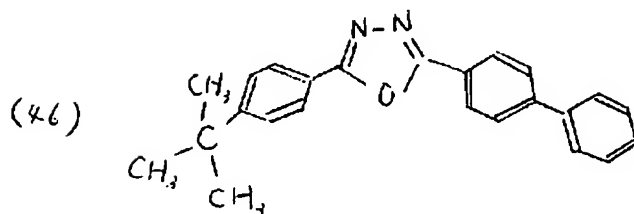
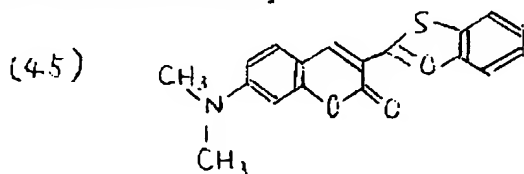
[0071] It connects with the transistor 32 at these organic EL devices, respectively, and the closure film 30 is further formed in the top layer.

[0072] 1 pixel is formed of these three elements, and a desired color is made to emit light from the polymer luminous layer 36, 37, or 38 by supplying voltage between the transparent electrode-counter electrodes of one of organic EL devices suitably with a transistor 32. It becomes possible to observe the color of this request from the transparent base 1 side as a result. In arranging such a pixel in two dimensions, the organic EL device of this invention can be used as a display device.

[0073] In addition, in the display device of this invention, it becomes possible to attain reinforcement of the whole display device because an octanol LogP value adds 6.5 or more dye molecules to the organic EL device which forms a red pixel. The compound indicated at a ceremony (15) was used in this example. The LogP value of this compound is 7.31 and used the compound indicated at a ceremony (41) which mixed this 1% as a luminous layer 36.

[0074] Moreover, the compound indicated at a ceremony (41) which mixed this with the dye molecule of the compound indicated at a ceremony (45) 1% as a material in which green luminescence is shown was used as a luminous layer 37. Moreover, the compound indicated at a ceremony (41) which mixed this with the dye molecule of the compound indicated at a ceremony (46) 1% as a material in which blue luminescence is shown was used as a luminous layer 38.

[Chemical formula 20]



In the display device shown in drawing 3 , a septum 34 is producible with a photoresist process. The positive hole transportation layer 35 can be formed using a spin coat or vacuum deposition. 36, 37, and each polymer luminous layer shown in 38 can carry out NGU printing of the organic solvent solution with an ink-jet printer at a putter.

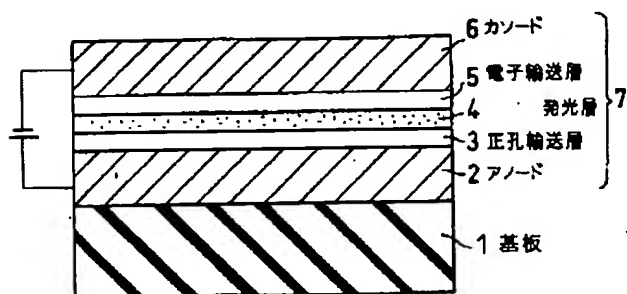
[0075] The reduction-by-half life when driving with the current sourcing of 20 mA/cm<sup>2</sup> of this display device was 15000 hours.

[0076]

[Effect of the Invention] This invention becomes possible [ offering the organic EL device of long lasting red light, and the long lasting display device using this ].

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[Translation done.]



[Translation done.]



## 【特許請求の範囲】

【請求項1】アノードと、カソードと、前記アノード及びカソード間に配置され、ホスト分子及び発光中心の色素分子を含有する発光層とを具備し、前記アノードから供給された正孔および前記カソードから供給された電子を前記発光層中で再結合させて前記ホスト分子を励起し、励起された前記ホスト分子のエネルギーを前記発光中心の色素分子に移動させて、前記発光中心の色素分子を発光させる有機EL素子であり、前記色素分子が、シアノ基を有する発光色素分子であり、そのオクタノールLogP値が6.5以上であることを特徴とする有機EL素子。

【請求項2】前記オクタノールLogP値が12以下であることを特徴とする請求項1記載の有機EL素子。

【請求項3】前記色素分子が炭素-フッ素結合を有することを特徴とする請求項1記載の有機EL素子。

【請求項4】前記ホスト分子はポリマーであり、前記色素分子は前記ポリマーをマトリックスとして前記発光層中に分散されていることを特徴とする請求項1記載の有機EL素子。

【請求項5】前記発光層は、炭素数1以上20以下の無置換のアルキル基、炭素数1以上20以下のハロゲン原子で置換されたアルキル基、炭素数1以上20以下のアリール基で置換されたアルキル基を具備するモノマーを含むことを特徴とする請求項4記載の有機EL素子。

【請求項6】前記色素分子がジシアノメチレン基を具備することを特徴とする請求項1記載の有機EL素子。

【請求項7】基板と、この基板に複数配列された有機EL素子とを具備し、当該有機EL素子の発光により表示を行う表示装置であって、

前記基板に複数配列された有機EL素子のそれぞれは、アノードと、カソードと、前記アノード及びカソード間に配置されホスト分子及び発光中心の色素分子を含有する発光層とを具備し、前記アノードから供給された正孔および前記カソードから供給された電子を前記発光層中で再結合させて前記ホスト分子を励起し、励起された前記ホスト分子のエネルギーを前記発光中心の色素分子に移動させてこの発光中心の色素分子を発光させる有機EL素子であり、

前記基板に複数配列された有機EL素子のうち少なくとも一つは、前記色素分子が、シアノ基を有する発光色素分子であり、そのオクタノールLogP値が6.5以上であることを特徴とする表示装置。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、有機EL素子および表示装置に関する。

## 【0002】

【従来の技術】有機EL素子は、自発光型、薄型軽量、低消費電力、フルカラー化を可能とする特徴から、液晶

ディスプレイを凌駕する可能性がある次世代のディスプレイの候補として注目されている。フルカラー化を可能とするためには、赤、緑、青色の光の3原色を基板上に配置する必要がある。この3原色のうち、すでに、緑色発光については十分な輝度及び長寿命が達成され、実用化されている。しかしながら、赤色や青色発光については、いまだ十分な輝度及び長寿命が達成されておらずフルカラー化を実現できていない。

【0003】この2色のうち赤色発光について、高輝度化、長寿命化を達成する方法のひとつとして、赤色発光する色素分子を低濃度でホスト分子の中にドーピングし、正孔および電子を再結合させてホスト分子を励起し、励起されたホスト分子のエネルギーを色素分子に移動させて、色素分子を発光させるゲスト-ホストドーブシステムが開発されている。

【0004】このゲスト-ホストドーブシステムに用いる赤色発光する色素としては、4-(ジシアノメチレン)-2-メチル-6-(p-ジメチルアミノスチリル)-4H-ピラン(DCM)に代表されるものがある。この色素はシアノ基を電子アクセプター基として、アミノ基のような電子ドナー基を共役鎖で結合したプッシュプル分子であり高輝度及び長寿命に有効であるとの報告がある(特開平10-308281号公報)。

【0005】しかしながら、プッシュプル分子は、極性が高く、かつ水や酸素などに反応しやすいシアノ基を有するため合成中に極性不純物が混入しやすく、極性不純物を取り除くことが困難である。極性不純物は余計なリーク電流等を引き起こし素子の寿命を低減させる問題がある。この、極性不純物の混入の問題は、スルーバックが比較的良好な方法であるキャスト法或いは印刷法に特に顕著である。

【0006】このように、シアノ基を電子アクセプター基として、アミノ基のような電子ドナー基を共役鎖で結合したプッシュプル分子は、高輝度及び長寿命に有効であるとの報告はある。しかしながら実際製造上シアノ基のように極性の強い基を有する色素分子は極性不純物が混入しやすく素子の寿命を低減させる問題がある。また、シアノ基のように極性の強い基を有する色素分子同士の会合力が大きく、ホスト分子と相分離しやすく発光効率が低下するという問題がある。また、相分離してしまうことによって、ホスト分子中に均一に色素分子が分散しないと発光の輝度が低下し、また色味が悪く表示素子としては粗悪なものになってしまうという問題がある。これらの問題により半減時間1万以上を達成し、発光効率が良好で色味も良好な赤色有機EL素子はいまだ実現されていない。

## 【0007】

【発明が解決しようとする課題】上述したように、赤色発光で十分な輝度及び寿命(半減時間1万時間以上)を実現し、かつ赤色の色味が良好な有機EL素子は実現さ